Heat-transfer & Aerothermal Laboratory (HAL)

Description:

The Heat-transfer and Aerothermal Laboratory conducts fundamental experiments in the areas of turbine aerodynamics, heat transfer and film cooling. Experiments are designed to improve our understanding of the complex flows found in turbine engines, and to provide validation data sets for numerical computations and for the evaluation of turbulence models for use in internal flow predictions. Measurement capabilities include pressure and temperature probes, thermal anemometry, Laser Doppler Velocimetry, Particle Image Velocimetry, thermocouple arrays, Liquid Crystal Thermography, and Infrared Thermography.

The laboratory maintains five active research rigs. The first is the Transonic Turbine Cascade, used for aerodynamic evaluation of blade geometries. The cascade features variable inlet incidence capability and upstream and downstream traverse systems for aero-probe loss measurements. Control of blade row backpressure and flow rate enables independent variation of exit Mach number and Reynolds number for off-design performance studies. The second research rig, the Advanced Cooling Research Rig, is a high temperature heat transfer and cooling effectiveness tunnel, designed to evaluate research specimens with advanced internal cooling features and external film cooling. The primary measurement technique used is infrared thermography through a cooled IR window. The third rig is the Boundary Layer Tunnel, a 50 cm by 30 cm by 4 m rectangular tunnel with a flexible upper wall, which enables the study of boundary layers and heat transfer under adjustable pressure gradients. The Boundary Layer Tunnel has been used to investigate film cooling, surface roughness effects, and flow control with plasma actuators. The fourth rig, the Leading Edge Film Cooling Tunnel, is a temperature-controlled wind tunnel with a single blade leading edge model designed for the study of near-stagnation heat transfer and film cooling. Superscale models provide high spatial resolution heat transfer data under varying freestream turbulence conditions. Research studies have included both steady and pulsed film cooling. The final rig and most recent addition to the laboratory, the Impingement Cooling Research Rig, is designed to investigate jet-to-jet interaction and the impact of cross-flow on heat transfer for impingement jet arrays.

Purpose:

To perform aerodynamic and heat transfer research in support of the development and validation of turbine aero and durability design methods.

Products:

Aerodynamic data for the validation of in-house turbine design tools.
Overall cooling effectiveness data for highly-coupled internal and external cooling concepts.
Flow visualization techniques to verify surface heat transfer and flow behavior such as boundary layer separation.
Steady and pulsed film cooling heat transfer data to support future turbine durability design.
Validation data to support transition model development.

Availability:

Primarily in-house and related DoD contractor research. Other U.S. Government agency, DoD contractor and commercial customer programs upon request. Contact: 937-255-2367.